

Phosphate Mobility in a Mars Analog Environment. J. W. Cornell¹ and E. M. Hausrath¹, ¹Department of Geoscience, University of Nevada, Las Vegas, Las Vegas, NV 89154, cornellj@unlv.nevada.edu, Elisabeth.Hausrath@unlv.edu.

Introduction: The Mars Exploration Rover Spirit has recently documented the P-rich classes of rocks Watchtower and Wishstone in Gusev Crater, Mars [1]. Apatite, which contains phosphorous, is a quickly dissolving phase [2] and therefore likely to be chemically altered on Mars. Specifically, wavellite, a secondary Al-phosphate phase, has been detected in the Watchtower class rocks of Gusev Crater by the mini-TES [3]. Strengite and ferristrunzite, Fe-phosphate phases, have also been detected by visible near infrared, thermal and Mössbauer spectroscopy in the P-rich Paso Robles soil of Gusev Crater [4].

Basalts from Craters of the Moon Lava Field (COM) in Southeastern Idaho have been proposed as a terrestrial analog to the P-rich Wishstone class rocks on Mars [5]. Phosphate forms different secondary products such as wavellite and strengite described above under varying conditions of pH, temperature, water:rock ratios and oxidation state. Therefore, examination of apatite dissolution and secondary phosphate formation in this environment may help interpret the behavior of phosphate on Mars.

Methods: Craters of the Moon Lava Field is a 1600 km² basaltic flow region in Southeast Idaho. Containing more than 60 lava flows ranging in age from 2,000 – 15,000 years old [6], the flows are unusual in that the compositions are widely varied but contain high amounts of phosphate. Although obviously wetter than Mars, COM is located in the high desert, receiving 290 mm of rain in the south to 380 mm in the north annually [6]. Samples were collected from the Kimama and Pronghorn flows, which are 10,240 +/- 120 and 15,100 +/- 160 years old respectively [6]. Samples were collected from the flows where they are exposed at the surface and beneath the loess to characterize two different weathering environments. Thick sections were prepared by cutting with an isomet saw using ethanol as the cutting fluid to avoid alteration of salts. Samples were also polished in ethanol.

Samples were imaged by Scanning Electron Microscopy (SEM) with a backscattered electron detector and Electron Dispersive Spectroscopy (EDS) using a JSM5610 at the Electron Microanalysis and Imaging Laboratory (EMiL) at the University of Nevada, Las Vegas (UNLV).

Results and Discussion: Porosity formed due to mineral dissolution is apparent to ~250-300 μm in samples collected from surface flows in COM (Figure 1). This result differs from observations of weathered

basalt samples of a similar age from Sverrefjel volcano, Svalbard, where only samples collected at depth indicated porosity due to mineral dissolution [7]. In samples collected from the land surface in Svalbard, the rock surfaces were primarily pristine, likely due to the repeated spalling of the surface [7]. The colder temperatures in Svalbard are the most likely cause for the difference between the two field areas.

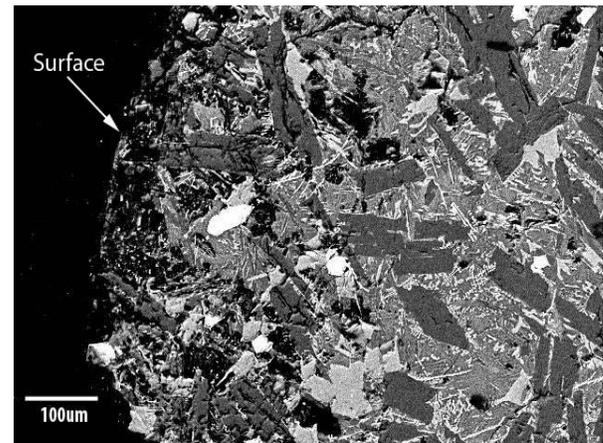


Figure 1 - Backscattered electron micrograph of a characteristic weathered sample from the surface of the Kimama flow (10 ka old) in Craters of the Moon Lava Field. Black areas present to a depth of ~300μm are pore space likely created by mineral dissolution.

Secondary Fe-phosphate phases are found in the chemically weathered zone of samples from the exposed surface of the Pronghorn flow. The Fe-phosphates are ~3-10 μm in diameter, occur in small groups and contain some Al (Figure 2-A). Al-phosphates are found in the weathered zone of samples from the exposed surface of the Kimama lava flow. The Al-phosphates range in size from 1-15 μm and are generally found near apatite crystals (Figure 2-B).

The presence of Fe-phosphate phases in samples collected from the Pronghorn lava flows, and Al-phosphates collected from the Kimama lava flows is most likely not due to differences in elemental composition between the two flows, which contain similar amounts of Fe and Al [6]. Differences in chemical composition may be due to natural variability or differences in the weathering environments.

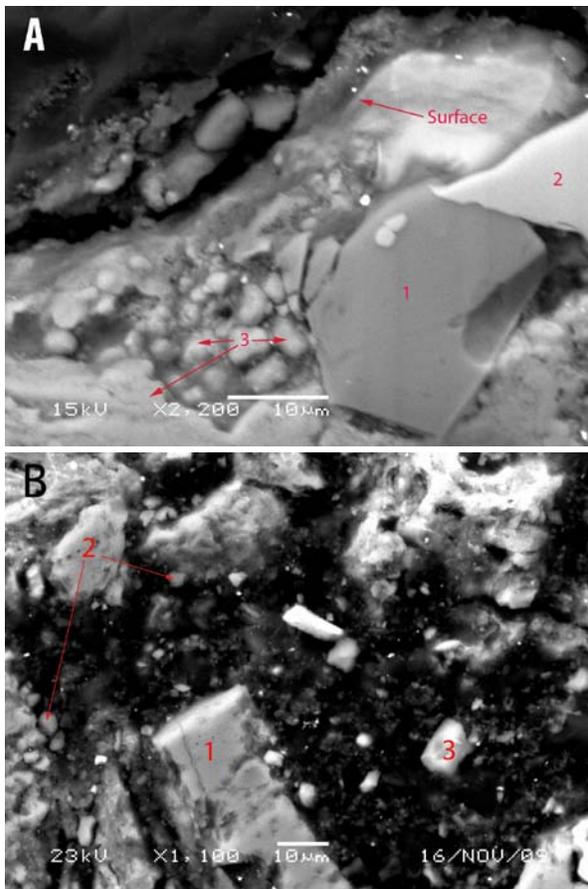


Figure 2 – Backscattered electron micrograph of **A**) characteristic Fe-phosphates formed in the chemically weathered zone of samples from the surface of the Pronghorn lava flow. Numbers indicate olivine (1), titanium oxide (2) and Fe-phosphates (3). The surface of the sample is indicated by an arrow. **B**) Al-phosphates are present in a crack ~50 µm from the surface of the Kimama lava flow. Numbers indicate apatite (1), Al-phosphates (2) and plagioclase (3).

Conclusion: In the weathered surfaces of samples from the Pronghorn and Kimama lava flows, porosity due to mineral dissolution is present to ~250-300 µm. Secondary phosphates containing Fe and Al are present in the weathered zone and may be similar to Al [3] and Fe-phosphates [4] previously documented on Mars. Future work will include further characterization of weathered surfaces of samples from a variety of flows from COM, including secondary phosphates. Quantifying these weathering processes should help us better understand phosphate mobility on Mars.

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References: [1] Gellert R. et al (2006) JGR, 111, E02S05 [2] Brantley S.L et al (2007) Kinetics of Water-Rock Interaction. [3] Ruff S.W. et al (2006) JGR, 111, E12S18. [4] Lane M.D. et al (2008) [5] Usui T. et al (2008) JGR, 113, E12S4 [6] Kuntz M.A. et al (1992) GSAM, pp. 227-266. [7] Hausrath E.M. et al (2008) Astrobiology, 8 (6), pp. 1079-1092.